APPENDIX B: HABITAT MANAGEMENT PLAN SUMMARY

B.1 HABITAT MANAGEMENT PLAN EXECUTIVE SUMMARY

The Turnbull Habitat Management Plan (HMP) was developed prior to the CCP and was signed in 1999 (USDI, 1999). The following appendix summarizes the HMP and presents all of the objectives and strategies written for the HMP.

In recent years, the mission and goals of the refuge have evolved from an emphasis on the production and maintenance of migratory waterfowl to a more holistic ecosystem management approach. The new mission is to restore and maintain ecosystem processes that provide for a natural diversity of flora and fauna native to the wetland, steppe and ponderosa pine communities of Eastern Washington. In order to fulfill this mission, specific goals were developed for each of the major plant communities, water quality and quantity, endangered and threatened species and maintenance of landscape connectivity.

An analysis of the current condition of the refuge ecosystem found that several factors limit the ability of the refuge staff to achieve these goals. These limitations are the outcome of past alterations to habitats and natural disturbance regimes by private landowners prior to refuge acquisition, subsequent refuge management, and increased urbanization of the area surrounding the refuge.

Significant non-point sources of nitrogen and phosphorus are entering the refuge from private lands north and east of the refuge. Refuge wetlands appear to have a greater susceptibility to drought that may be the result of increased usage of the water table for domestic and agricultural uses around the refuge, artificial recharge deficits as a result of extensive management drawdowns, and decreasing water yield from increased forest cover in refuge watersheds.

Past logging, grazing and suppression of fire has created pine stands with tree densities 2 to 4 times the pre-settlement condition. Large trees greater than 24 inches (60 cm) in diameter constitute less than 10% of the stands. Greater than 75% of the refuge ponderosa pine forest exists as closed canopy, multi-storied stands with a similar age and size structure. The forest understory is dominated by decadent snowberry and a dense layer of organic debris that suppresses the growth of native bunchgrasses and forbs. Fuel loading in refuge pine stands is 5 times greater than the average for this forest type. Conditions are ripe for catastrophic loss due to insects, disease, and fire.

The average density of snags in refuge forest stands is less than 1 per acre. Optimum conditions for cavity nesting birds require on the average 3 suitable snags per acre greater than 15 inches (38 centimeters)in diameter. Past logging and suppression of fire has resulted in the loss of mature and old growth stands that produce large diameter snags that persist over long periods of time. Existing stands are overstocked with pole and sapling sized pines that suppress tree growth and root development. Most snags are less than 15 inches (38 centimeters) in diameter and are susceptible to decay and windfall. Aspen/deciduous shrub habitat important habitat for a large number of refuge neotropical migratory landbird species has been significantly reduced on the refuge by competition from encroaching ponderosa pine and the suppression of aspen and shrub regeneration by past grazing. Aspen and deciduous shrub dominated plant communities have been reduced by 65%. In the past, periodic fire removed encroaching pines and encouraged regeneration of aspen and understory shrubs.

Wet meadows and seasonal wetlands have been invaded by reed canarygrass (*Phalaris arundinacea*), an exotic perennial grass which out competes nearly all native plant species. Gone are the diverse seasonal wetland habitats dominated by native sedges, rushes, and grasses. Water howellia, a federally threatened aquatic plant species restricted to seasonal wetlands, is at risk of being displaced by reed canarygrass.

Nearly 300 acres of seasonal wetland habitat has been impacted through the creation of over 700 nesting islands. These islands were created from spoil pushed up in the seasonal portion of several large sloughs and smaller potholes. Built too close to shore and each other and in water too shallow to prevent access by predators, these islands have not been used successfully by nesting waterfowl.

Exotic species such as cheatgrass brome (*Bromus tectorum*), Canada thistle (*Cirsium arvense*), dalmatian toadflax (*Linaria dalmatica*), St. Johns wort (*Hypericum perfoliatum*), spotted and diffuse knapweed (*Centaurea diffusa* and *C. maculosa*), and leafy spurge (*Euphorbia esula*) are present in refuge plant communities. Although limited in distribution on the refuge through integrated pest management practices. The potential exists for expansion without continued management effort. Cheatgrass is dominant in many areas of the refuge displacing native perennial grass and forb communities.

The refuge occurs on a narrow extension of the Ponderosa Pine Zone into the Columbia Basin. This peninsula of ponderosa pine forest surrounded by intensively developed agricultural land is in danger of being isolated from the rest of the forested zones to the north by urban development around Spokane and the Interstate 90 corridor. Further isolation has resulted from forest practices on private lands surrounding the refuge. Past and current timber management activities on these lands have created either suppressed stands of ponderosa pine vulnerable to catastrophic fire or relatively young even aged stands of trees with little structural diversity.

Both qualitative and quantitative objectives have been established to provide more detailed direction and targets that will need to be met in order to achieve refuge goals. Objectives address limitations to meeting refuge goals identified by the Service, the habitat needs of native wildlife species, and the maintenance of the integrity of the refuge in its ecoregional setting. The habitat needs of wildlife species were addressed using a wildlife guild concept that groups wildlife by their common use of 10 different habitat strata for both breeding and foraging. Because guilds are often large, key management or indicator species were selected for each guild to focus management actions. These species were chosen because of legislative mandate(threatened or endangered), their significance to conserving biodiversity, the critical status of their populations, or the fact that their habitat requirements represent a subset of the membership of their respective guild.

Management strategies have been developed to meet these objectives. These strategies include both manipulative and administrative actions that will be applied over the next 15 - 20 years.

- Manipulative actions will include restoration of fire through prescribed burning, tree removal utilizing a variety of silvicultural methods, noxious weed control, livestock grazing, water management, wetland restoration, and riparian and grassland vegetation restoration.
- Administrative actions will primarily involve increased coordination with other public agencies and private landowners to protect the quantity and quality of water entering the refuge and prevent the further isolation of the refuge resulting from increased urbanization of landscape linkages.

Specifically these actions will involve:

- Silvicultural treatment of approximately 400 acres annually for the next 15 years using a combination of non-commercial and commercial thinning, single tree selection harvest, and group selection harvest to achieve a natural distribution of stand conditions.

- Prescribed burning of between 800 - 1600 acres per year.

- Continuation of integrated weed management using either singly or in combination, cultural, chemical, biological, or mechanical management practices.

- An experimental program to control reed canarygrass in seasonal wetland habitat and restore native plant diversity in cheatgrass dominated steppe and forested habitats.

- A refined water management program to meet objectives for emergent vegetation and open water in 22 managed wetlands.

- Restoration of the natural contours of 29 altered wetland basins by removal of artificial islands and berms.

- Coordination and cooperation with local, county, and state regulatory agencies and private landowners to reduce threats to water quality and quantity.

- Use of available incentive programs to change private land-uses that are impacting the quality and quantity of water entering the refuge.

- Use of fee or easement acquisition from willing sellers when necessary to protect water quality and quantity, water howellia habitat, meadow steppe plant communities and landscape linkages.

- Research would be initiated to answer critical questions about habitat requirements and species biology of water howellia in order to design sound management plans for restoring and maintaining natural occurrences.

Full implementation of this plan will cost approximately $330,000 annually. Primary costs are associated with the need for the equivalent of three full-time personnel for planning, implementation and monitoring of forest and prescribed fire management and 1 full time equivalent employee for wetland restoration work. Additional costs are associated with equipment, fuel, native plant materials, research contracts, and outreach.

This plan takes an adaptive management approach. Habitat monitoring will be undertaken to insure that assumptions made in developing strategies are correct. If objectives are not being met then corrections can be made. Monitoring procedures have ben been or will be developed for each breeding and foraging strata and water howellia.

Implementation of this plan over the next 20 years should result in improved water quality and quantity, improved wetland conditions, improved forest health, increased stand diversity and snag densities, reduction in the risk of stand replacing wildfires, restoration of native plant diversity, increased area of aspen riparian habitat and maintenance of landscape linkages.

B.2. HABITAT MANAGEMENT OBJECTIVES AND STRATEGIES

In order to achieve refuge goals and resolve resource challenges, both qualitative and quantitative objectives were established that address the habitat needs of breeding and foraging guilds as well as maintaining the integrity of the refuge in its ecoregional setting. Habitat objectives for guilds are mostly quantitative and were set to restore and maintain specific habitat elements using guild management guidelines. Recognizing that these guidelines represent optimum conditions, refuge objectives were

tempered by the natural capacity of the refuge to provide these elements. The overriding theme in the objective setting process is the restoration and maintenance of ecological processes that produce a natural diversity and distribution of habitats. These ecological processes are dynamic resulting in variations in the abundance and distribution of habitat strata both spatially and temporally. Because of this variability, objectives generally cover a range of values. Objectives for achieving goals necessary to maintain the ecological integrity of the refuge in the larger landscape are more qualitative and deal with minimizing the effect of off-refuge activities on refuge resources.

GOAL#1. Provide habitat conditions essential to the conservation of migratory birds and other wildlife within a variety of wetland complexes.

1A. OPEN WATER ACREAGE OBJECTIVE: Manage the 22 refuge wetlands with water control capability at a level that maintains between 500 and 750 acres of permanent open water annually to support the water surface and emergent stratum breeding guild.

Guild Management Guidelines

Water surface breeding guild

- For every 1000 acres of habitat, maintain at least one large wetland, greater than 100 acres, with deep water and beds of dense submerged aquatic plants available from March 15th to August 30th.

Emergent stratum breeding guild

- Permanent wetlands should be maintained at a density of 2 ponds per square mile larger than 50 acres.
- Between 30 and 50% of a permanent wetland basin should be managed as open water in blocks of at least 25 acres in size.
- Open water areas should contain interspersed patches of dense, submerged aquatic plant beds. Submerged aquatic plants provide a substrate for invertebrate production. Aquatic invertebrates are critical to egg production, the maintenance of incubating females and growth and survival of broods.

Strategies

- Maintain water control capability in 22 permanent wetland basins and establish peak operating levels of the 22 managed wetlands to achieve objectives for wetland strata(Table 4 in HMP). Stabilize water levels in all managed wetlands by April 1.
- Develop contour maps of the 22 managed wetland basins. These maps will allow the use of existing wetland vegetation models that account for annual runoff and evapotranspiration to establish operating levels that will achieve wetland strata objectives over the long-term.
- Until contour mapping is completed, peak water levels will be based on existing operating levels (Table 5). Interim adjustments to operating levels will be made if monitoring indicates that objectives for wetland strata are not being met.
- Because the bottom of the control structure is often higher than the lowest point in the basin, a piezometer well is required near the structure of each managed wetland to measure the level of the water table and water use to refine water management and support existing water rights and claims. Piezometer wells are currently in place at Kepple Lake, Upper Turnbull, Lower Turnbull and Long Lake. The topography of these four wetlands will be surveyed and mapped first. Eighteen more piezometer wells will be placed at the remaining managed wetlands.

Rationale:

There are 22 wetlands with water control structures where water levels can be established that will meet habitat objectives for a range of values for open water, emergent vegetation and water depths. Meeting these objectives will provide the strata necessary to support wetland breeding and foraging guilds. Water levels can be established using both vegetation simulation models and empirical data. Supplemental water can be used to augment local runoff to reach these water levels. It is important to note that even with supplemental water it will not be possible or desirable to maintain stable quantities or distributions of different vegetation zones and water depths within a wetland basin overtime. Long-term stability of wetlands is often associated with declining productivity in terms of the interspersion of wetland vegetation zones, productivity and composition of submerged aquatic plant communities, and the diversity and abundance of aquatic invertebrates. Use of supplemental water can, however, reduce the extremes of natural cycles and maintain objective levels of wetland strata for longer periods of time.

Peak operating level for each managed wetland basin that will have the greatest probability of meeting objectives for wetland strata can be established using wetland vegetation models. Rules for the model have been empirically derived for prairie pothole wetlands to predict changes in wetland vegetation zones as a result of different hydrologic inputs (van der Valk 1981). The rules predict conversion from one vegetation type to another as a result of different drawdown and flooding scenarios. These rules have been incorporated into spatial simulation models to predict potential effects of global warming on prairie wetlands (Poiani and Johnson 1991). Recently this model with some modifications was applied to a wetland basin on the refuge with good predictive ability (Mahrer 1995).

1B. EMERGENT PLANT STRATA OBJECTIVE: Establish an annual operating level for the 22 managed wetlands that maintains an emergent plant strata that covers between 10% and 30% of the wetland basin to support the emergent and water surface stratum breeding and foraging guilds. Fifty percent of this zone should have a width of greater than 100 feet.

Guild Management Guidelines

Emergent Stratum Breeding and Foraging Guilds

- The ratio of open water areas to emergent plant beds should be near 1:1. At least half of the emergent plant beds should be at least 100 feet in width to provide adequate area for the establishment of territories and security for nesting.
- Stem densities should be greater than 14 stems per square foot in at least 50% of the emergent stands.

Strategies

(see Strategies for Objective 1A)

Rationale

See rationale for Objective 1B

1C. WATER DEPTHS IN EMERGENT PLANT ZONE OBJECTIVE: Manage water annually to maintain water depths of at least 18 inches in the emergent plant zone of managed wetlands from April 1 through July 30 for nesting birds in the emergent stratum breeding guild.

Guild Management Guidelines

Emergent Stratum Breeding Guild

- Water depths in hardstem bulrush stands should not drop below 18 inches (45 cm) from April 1 to July 30.

Strategies

(see Strategies Objective 1A)

Rationale

Maintenance of the specified minimum water depths in managed wetlands during the nesting season is critical to the success of nesting attempts by members of the emergent stratum breeding guild (Low 1945, Lokemoen 1966, Siegfried 1976, and Stoudt 1982). Adequate water depths mainly serve to limit access to the nest by potential predators.

1D. RESTORATION OF NATURAL HYDROLOGY OBJECTIVE: By 2007, restore the natural hydrology of 250 acres of managed wetlands that occur in isolated watersheds and are not downstream from off refuge water sources.

Guild Management Guidelines

Emergent Stratum Breeding Guild

- A diversity of wetland types and sizes are required to meet all wetland associated needs of this guild seasonally and annually.
- Fluctuating water levels seasonally and between years promotes both a temporal and spatial diversity of conditions in emergent stands. Under these conditions, suitable habitat is provided for all guild members over the long-term.

Water Surface and Water Column Feeding Guilds

- Without full water management capability, maintenance of a complex of natural wetlands with dynamic hydrologic cycles will provide the greatest diversity of foraging opportunities during spring and fall migration periods.

Bare Surface Feeding Guild

- A complex of wetlands with different hydrologic regimes, will provide the diversity of habitats required by all waterbird species in a localized area.

Strategies

•	The long-term strategy should be to maximize water retention in these basins. Existing water control structures (McDowell Lake, 30-Acre Lake, and Hale Lakes) can be replaced by a spillway set at a desired maximum level. Drainage ditches can be back-filled and the wetland basin returned to its natural configuration by removal of near shore islands and recontouring.

Rationale

Several previously drained wetlands on the refuge occur at the head of a drainage system and do not receive supplemental water from other wetlands. Because supplemental water is not available to recover from drawdown or maintain water depths over extended periods of time in these wetlands, active water management is not generally feasible. Based on overall depth, wetlands in this category can be separated into two types. The deeper wetland type with greater than 20% permanent open water has little need for a water control structure because drawdowns can result in artificial deficits that may be difficult to overcome in all but the wettest years without supplemental water. The remaining wetlands in this category are more shallow and seasonal in nature and have no permanent open water. This may be the result of either a shallower natural basin or the placement of a water control structure below the elevation of the natural outlet. As a result of the shallowness of these wetlands, they are often dominated by reed canarygrass. Control of reed canarygrass in these managed wetlands can be accomplished in part by raising the elevation of the outlet to allow deeper flooding.. This is an option in wetlands such as Palmer Meadow where the maximum elevation of the current outlet is lower than the pre-drainage outlet .

1E. RESTORATION OF NATURAL BASIN TOPOGRAPHY OBJECTIVE: By 2017, restore the natural basin topography and historic wetland function of 29 wetlands that have been manipulated in the past to create deeper wetland habitat and waterfowl nesting islands.

Guild Management Guidelines

Water column breeders

- Natural basin topography should be maintained or restored to a 10:1 slope to provide the necessary shallow, warm water areas needed for maintenance of this guild under a variety of water conditions.

Terrestrial covered surface breeders

- Islands can be excellent predator free breeding habitat for waterfowl members of this guild when they are located in the right environment. Critical features include a distance from shore of at least 160 feet, maintenance of water depths in excess of 50 inches around islands throughout the breeding season, a spacing of at least 60 feet between islands, and no more than two islands per 20 acres of wetland area.

Water column and water surface feeders

- Whenever possible large wetlands with gentle shoreline slopes should be flooded in the winter and spring to a depth that maximizes the amount of shallow flooded shoreline areas. These wetlands should be allowed to drawdown naturally through the spring and summer. These large wetlands have the highest potential for providing a sustained diversity of foraging strata for this guild overtime.

Bare surface feeders (shorebirds)

- Availability of exposed mudflats and an adjacent, shallow wetland zone with less than 25% vegetative cover from mid-June to the end of September is key to the maintenance of this guild during migration.
- Wetlands with a gradual sloping bottom provide a greater diversity of water depths and shoreline edge resulting in greater invertebrate diversity. As food diversity increases so does the diversity of species using different foraging strategies.

Strategies

- There are 29 wetland basins that have been manipulated through ditching, excavation of emergent plant beds and/or construction of nesting islands(Table 6 and Figure 5 of HMP). Primary restoration activities will involve the removal of the 427 islands and berms that do not meet minimum requirements (see terrestrial covered surface guild guidelines, Appendix D of HMP) for secure nesting islands. The material from both islands and berms will be pushed back into the borrow areas and recontoured to the original slope of the wetland basin. Because of the large quantity of work, only 3 small wetlands or a single large managed wetland will be restored per year. To avoid creating artificial recharge deficits, large, managed wetlands should not be drawn down to gain access for restoration work . The larger permanent wetlands may not be accessible until a year or two of below average recharge. The shallower more seasonal wetlands can generally be accessed during the late summer and fall of most years. All manipulated wetlands will be surveyed for the presence of water howellia prior to treatment.

Rationale

From 1968 to 1985, nearly 300 acres of seasonal wetland habitat has been impacted through the creation of over 700 nesting islands and activities to increase the interspersion of open water and emergent vegetation. The islands were created from spoil pushed up in the seasonal portion of several large sloughs and smaller potholes. Built too close to shore and each other and in water too shallow to prevent access by predators, these islands have not been used successfully by nesting waterfowl. Island construction resulted in the direct loss of seasonal wetland habitat by burial and the scrapes often exposed the underlying tephra layer. These areas are in general devoid of a vegetative substrate for egg attachment, predator escapement and aquatic invertebrates, the primary food source. In some wetlands, the entire shoreline area has been recontoured to a more abrupt slope. The potential negative impact to the water column breeding guild is the loss of the gentle shoreline gradient that provides shallow, warmwater breeding sites and foraging areas for hatchlings and older larvae.

1F. REED CANARYGRASS CONTROL OBJECTIVE: By 2000, develop and apply on an experimental basis management strategies to restore and maintain native plant communities of seasonal wetlands and wet meadows dominated by reed canarygrass.

Guild Management Guidelines

Bare surface feeders (shorebirds)

- Availability of exposed mudflats and an adjacent, shallow wetland zone with less than 25% vegetative cover from mid-June to the end of September is key to the maintenance of this guild during migration.

Water column and water surface feeders

- Whenever possible large wetlands with gentle shoreline slopes should be flooded in the winter and spring to a depth that maximizes the amount of shallow flooded shoreline areas. These wetlands should be allowed to drawdown naturally through the spring and summer. These large wetlands have the highest potential for providing a sustained diversity of foraging strata for this guild overtime.

***Howellia* guidelines**

- Evasive exotic species capable of invading water howellia habitat, such as reed canarygrass, may through competition for light and space reduce or eliminate the area of suitable habitat in a wetland basin.

Strategies

- There are 4 wetland basins (Helms Meadow, Schaefer Meadow, Palmer Meadow, and McDowell Meadow that have large enough stands of reed canarygrass to warrant the use of replacement control strategies (HMP Figure 6). Experimental plots will be established in these areas to test various restoration strategies involving the use of deep flooding, prescribed fire, high intensity short duration grazing, haying, herbicides, discing and seeding. Although these sites are not typical water howellia habitat, a survey will be conducted prior to any treatment. Treatments found to be effective will be applied n a larger scale. This site and future experimental treatments will be monitored to determine their success in restoring native plant communities.

Rationale

Wet meadows and seasonal wetlands have been invaded by reed canarygrass (*Phalaris arundinacea*), an exotic perennial grass which out competes nearly all native plant species. Gone are the diverse seasonal wetland habitats dominated by native sedges, rushes, and grasses. Loss of native plant diversity and the heavy accumulation of litter and higher stem density of reed canarygrass areas decreases the biodiversity of the refuge and severely limits use by wetland dependent wildlife. Water howellia, a federally threatened aquatic plant species restricted to seasonal wetlands, is at risk of being displaced by reed canarygrass.

GOAL#2. Protect and restore water quality and quantity sufficient to maintain native wetland flora and fauna.

2A. WATER RIGHTS REVIEW OBJECTIVE: By 1999, review the status of current adjudicated water rights and all claims for water rights and update to coincide with current water management objectives.

Strategies

- Work with the Regional Engineer to review current adjudicated water and all water right claims to assure they coincide with current water management objectives.

Rationale

The Service has claims on all major drainages flowing onto the Refuge but only five water rights have been adjudicated. The majority of the Refuge's water rights are still unadjudicated claims. The State of Washington has no immediate plans to complete the adjudication of claims in this area. It will be likely many decades before the Refuge has a final determination of its water rights. Although the Refuge's claims are valid water rights which allow for the diversion and use of water in the Refuge wetlands,

because they are unadjudicated, the State will not regulate other water users to protect the Refuge's water rights. Therefore, the water supply to the refuge may be threatened.

2B. MONITORING OF WETLANDS LEVELS OBJECTIVE: Annually monitor wetland recharge and water losses for the 22 managed wetlands to quantify water usage and the status of local groundwater resources.

Strategies

- Contour maps of the 22 managed wetland basins will be developed through contract surveying or by refuge staff using a geographic positioning system and measurement of water depths relative to the water control structure. Contour maps and water level monitoring will allow calculation of water volumes in individual basins. Because the bottom of the control structure is often higher than the lowest point in the basin, a piezometer well is required near the structure of each managed wetland to measure the level of the water table and water use to support existing water rights and claims. Piezometer wells are currently in place at Kepple Lake, Upper Turnbull, Lower Turnbull and Long Lake. The topography of these four wetlands will be surveyed and mapped first. Eighteen more piezometer wells will be placed at the remaining managed wetlands. adjudicated water and all water right claims to assure they coincide with current water management objectives.

Rationale

Monitoring of groundwater and wetland water levels on the Refuge has clearly demonstrated that wetland water levels are supported through the summer months by inflow from the shallow water table. The greater the number of wells drilled into the local aquifer, the higher the likelihood that subsurface water flows to Refuge wetlands will diminish, ultimately affecting Refuge habitats for waterfowl and other species.-Most of the current and future domestic and industrial development in the area is reliant on groundwater withdrawals from the local shallow aquifer, much of which is unregulated. Under State regulations, individual and Group B (2-14 connections) systems pumping less than 5,000 gallons per day are exempt from the standard water permitting procedure. In addition, the city of Cheney has recently added additional deep municipal wells. The number of new wells and the lack of institutional mechanisms to curb groundwater "mining" pose a threat to the shallow aquifers in the area. Use of the aquifer faster than its recharge rate will result in a lowering of the water table. There is indication that drought, coupled with increased domestic well use, has lowered the water table on the Refuge already. With shallower wetlands, we will see increased encroachment of the invasive species, reed canary grass, together with other marsh edge species. This would negatively affect the production of waterfowl and other waterbirds through declining acres of open water and a lack of adequate brood rearing habitat in summer.

2C. WATERSHED YIELD OBJECTIVE: Restore and maintain the natural water yield of refuge watersheds through restoration of open forest conditions and riparian habitats within the annual forest treatment areas.

Strategies

See strategies under Objectives 3A and 3C.

Rationale

The hydrologic regime of many small wetlands have been altered through changes in the density of coniferous forest cover in local water sheds. Reduction of coniferous forest cover and restoration of deciduous riparian vegetation should increase water yields through decreased transpiration and interception of precipitation (Gifford et al. 1984). Coniferous trees transpire for a longer period of the year than either deciduous woody vegetation or grass and forbs. The presence of tree foliage throughout the year in coniferous forest results in the interception of a greater amount of snowfall by the tree canopy. This results in less snow pack and potentially less runoff to wetland basins. It is likely that intercepted snow evaporates more readily than snow on the ground because of the greater surface area exposed to solar radiation and wind (Debyle 1985).

2D. WATERSHED QUALITY COORDINATION OBJECTIVE: By 2000, identify properties adjacent to the refuge that contain large portions of the four major drainage systems that enter the refuge and their watersheds, and coordinate with federal, state, and local agencies to identify and reduce non-point sources of pollution and to protect water quantity.

Strategies

See strategies for objective 2F in CCP.

Rationale

Grazing and mechanical disturbance of soil associated with the use of heavy equipment during habitat improvement work on the refuge can potentially affect water quality through increased erosion and sediment transport to wetlands. Heavy concentrations of livestock can deposit nitrogenous waste into wetlands resulting in eutrophication. Drained wetland basins on private lands are currently used as pasture and hay for livestock. Many of these basins are drained by the four major ditches that enter the refuge. A study of water quality completed on the refuge in 1992 by Eastern Washington University (Whalen et. al. 1992) found high concentrations of nitrogen and phosphorus entering the refuge in drainwater from both the Kaegle and Phillips Ditch. The private pastures drained by these two ditches are used as pasture in late summer and fall and during the winter as feedlots. Spring thaw and rain transports the accumulated animal waste into the drainage ditch and onto the refuge. The result is nutrient enrichment of affected wetlands resulting in extensive algal blooms. Algal blooms caused severe oxygen debt and the death of fish and invertebrate species. Dense algal mats in late summer restrict access of young waterfowl to invertebrate and plant food resources.

All homes outside the Cheney city limits are on septic systems. The majority of residential development within a mile of the refuge will be using septic systems. There is a strong possibility these systems could contaminate the shallow aquifer resulting in nutrient enrichment and eutrophication of refuge wetlands.

In 1992, a potential landowner applied for a permit from the county to allow placement of an auto wrecking yard adjacent to Philleo Ditch. During a public hearing, the refuge manager and several private citizens testified to the importance of Stubblefield Lake to wildlife and the inadequacy of the applicant's environmental checklist as required by the State Environmental Protection Act. The hearing officer found the checklist inadequate and denied the permit until the applicant completed a more thorough review. The applicant has not yet reapplied. As the area around the refuge becomes increasingly urbanized there will be other applications of this sort and a real potential for contamination of surface and ground waters entering the refuge.

GOAL #3. Restore refuge forest to a natural distribution of stand structural and successional stages to benefit forest dependent wildlife.

3A. RESTORATION OF PONDEROSA PINE OBJECTIVE: Restore and manage refuge ponderosa pine forest through the annual treatment of a minimum of 400 acres to improve forest health, restore diverse native understory plant communities and maintain natural tree densities and the distribution and diversity of stand conditions necessary to sustain native forest-dependent wildlife(Figure 3 and Figure 4).

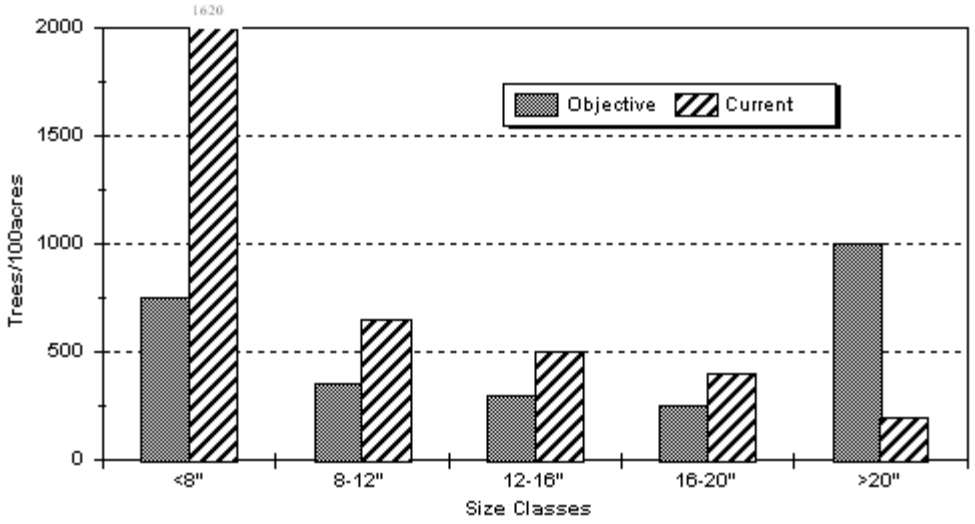

Figure 3 . Comparison of objective and current mean tree densities by size class.

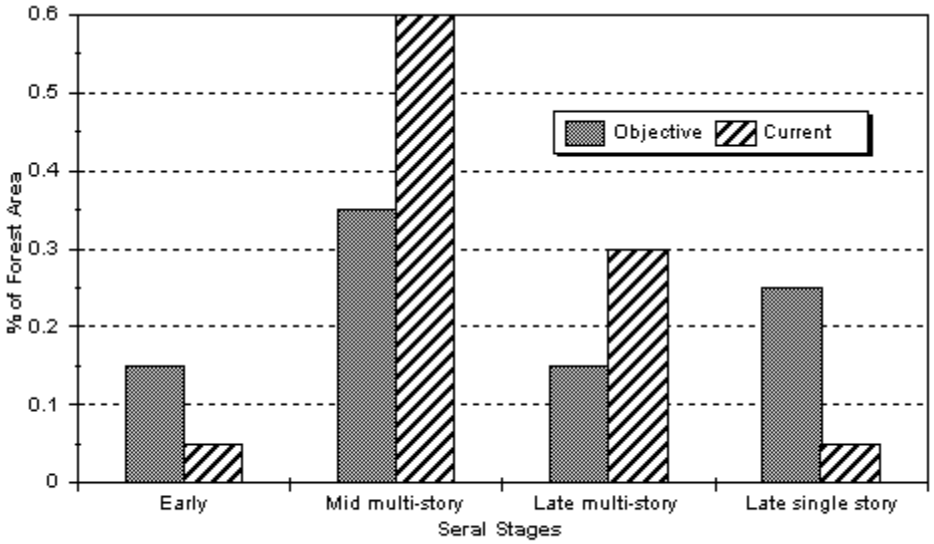

Figure 4. Comparison of objective and current distribution of forest seral stages.

Guild Management Guidelines

Tree canopy breeders

- In general, higher breeding densities of individual guild members are associated with greater height to the bottom of the tree canopy and greater volume of individual tree canopies.
- The majority of the guild membership are found more frequently and in greater abundance in open forest that provide access to open air spaces and surface and shrub strata for foraging.

Cave/Crevice breeders

- The plant community and the structural or successional stage in which these features occur and the proximity of preferred foraging strata may be important determinants of suitability. Management of the refuge for a natural distribution and diversity of plant communities and structural and successional stages should met the needs of all guild members.

Terrestrial sub-surface breeders

- Highest densities of fossorial guild members are found in areas of deep soils with a minimum of rock.
- Successional stage and structure of the overlying plant community and the proximity to water are important determinants of habitat suitability.
- Deep soil habitat with open or early successional plant cover with an abundance of herbaceous forb species is important to both key indicator species, the northern pocket gopher and Columbian ground squirrel.
- Maintenance of the natural distribution and diversity of successional stages and structural classes on these deep soil sites should meet the needs of this guild.

Terrestrial Covered surface feeders

- In general, maintenance of a natural distribution and diversity of plant communities and successional stages will provide the habitats necessary to sustain this guild during migration and wintering periods.

Strategies

- In general, trees greater than 24 inches should be reserved.
- Unless the lack of larger size class prevents meeting tree density objectives, tree stems less than 8 inches in diameter should be cut and removed from the site. If left on site, they should be piled for later burning.
- Commercial harvest should be employed to remove excess trees in intermediate size classes. Single -tree selection and group-selection should be used to create a grouped spatial arrangement of different densities and size classes, including openings for future regeneration.
- All commercial harvest involving the use of heavy equipment should take place in the winter when soils are frozen and snow covered
- Thinning and commercial harvest activities should be followed up with low intensity/high moisture burn to remove a portion of the slash and piles. Another higher intensity/low moisture burn should be completed in the late summer or fall of the following year to complete fuel reductions and understory treatment.
- Treatment units should be burned again at approximately 10 to 25 year intervals to mimic natural fire return intervals (Arno 1988 and Kinateder and Stein 1998).

Rationale:

Based on studies in ponderosa pine communities in the Southwest, pre-settlement stocking densities of ponderosa pine stands ranged from 19 - 47 trees per acre (Covington and Moore 1994). Trees were often found in relatively even-aged clumps approximately 0.07 acres in size (Cooper 1961, West 1969, White 1985). Although a diversity of different age and tree densities were present in the landscape, the overall aspect of the forest was open and park-like, with predominately large diameter trees in single-storied stands(Quigley and Arbelbide 1996). The bottom of the tree canopy was higher as result of frequent pruning by ground fires. This higher canopy resulted in less needle scorch and needle fall. These higher canopies and more open stands favored many members of the canopy and tree and snag bole breeding and aerial feeding guilds. The presettlement understory consisted of a dense ground cover of bunchgrasses or low shrubs that favored ground breeding and foraging species. Common snowberry and Wood's rose, although common, were probably less abundant and represented by a higher proportion of live stems as a result of frequent low intensity ground fires. Excessive accumulations of needles and other organic debris would have been reduced by these fires promoting the development of cryptogamic soil crusts on bare soils between the low shrubs and bunchgrasses. These understory conditions provided valuable breeding and foraging habitats for members of the terrestrial covered surface breeding and foraging guilds.

Past logging, grazing and suppression of fire has created pine stands with tree densities 2 to 4 times the pre-settlement condition. Large trees greater than 24 inches (60 cm) in diameter constitute less than 10% of the stands. Large portions of the refuge ponderosa pine forest have a similar age and size structure. The forest understory is dominated by decadent snowberry and a dense layer of organic debris that suppresses the growth of native bunchgrasses and forbs. Fuel loading in refuge pine stands is 5 times greater than the average for this forest type. Gone is the open park-like savanna of large ponderosa pine trees with an understory of bunchgrasses and forbs typical of this forest type. Conditions are ripe for catastrophic loss due to insects, disease, and fire.

3B. SNAG RECRUITMENT OBJECTIVE: During annual forest treatments, provide conditions in refuge ponderosa pine and aspen stands that result in recruitment of the density and distribution of snags necessary to sustain 40% of the maximum potential breeding populations of cavity excavating wildlife species (Table 3).

Table 3. Objective and current snag densities (snags/100acres) in ponderosa pine and aspen stands of Turnbull National Wildlife Refuge.

	Ponderosa Pine		Aspen	
Size Class	Objective	Current	Objective	Current
> 12 inches	309	74	144	1862

Guild Management Guidelines

Tree bole and Snag breeders

- The larger the tree or snag diameter the better. As a rule, most guild members use snags or trees greater than 15 inches in diameter at breast height.
- Snags are more valuable in clumps than individually.
- Trees with large diameter dead tops are important snag resources because of their height and greater longevity
- Forest stand conditions should provide a density of snags necessary to maintain at least 40% of the maximum breeding population of cavity excavators. A good rule of thumb is a density of approximately 3 hard snag equivalents per acre.

Strategies

- Long-term strategy for meeting objectives for snags and downed woody material requires the restoration and maintenance of forest stand conditions that foster recruitment and retention of large diameter snags.(see Strategies Objective 3a). Forest conditions should promote the growth of larger, older trees that are more resistant to decay and less susceptible to crown scorch. These conditions should also deter large scale disturbances that kill large numbers of trees and limit the ability of damaged trees to respond to insect attack.
- Because of the current low numbers of snags in refuge pine stands, meeting snag density objectives in the short-term will require increasing snag recruitment and retention. Snags can be created in association with forest restoration activities through the use of fire, girdling, or blasting.
- An alternative to snag creation is the use of artificial nest boxes until snag objectives are met through forest restoration. Nest boxes also provide an opportunity to monitor the productivity of cavity using species.

Rationale

Since trees near the end of their physiological life were present in many presettlement stands, there were probably a fair number of large dbh snags available within the landscape. These larger snags were more resistant to rot and windfall and probably persisted for decades providing an adequate habitat base for

cavity using wildlife requiring more open habitat. Keen (1961) reported average snag densities of 4 snags per acre in ponderosa pine forest in the early part of this century. Densities ranged from 1.1 to 7.9 snags per acre. This range of densities correspond with the recommendations of several researchers studying the needs of cavity using wildlife (Balda 1975, Cunningham et al. 1980, Scott and Oldemeyer 1983, Raphael and White 1984).

The current average density of snags in refuge forest stands is less than 1 per acre. Past logging and suppression of fire has resulted in the loss of mature and old growth stands that produce large diameter snags that persist over long periods of time. Existing stands are overstocked with pole and sapling sized pines that suppress tree growth and root development. Most snags are less than 15 inches(38 centimeters) in diameter and are extremely susceptible to blow down.

3C. ASPEN / RIPARIAN RESTORATION WITHIN PINE CLIMAX STANDS

OBJECTIVE: Within annual forest treatment units, restore the natural diversity of stand conditions and the dominance of aspen and native deciduous shrub species in riparian habitat now dominated by Ponderosa Pine to increase the number and size of habitat patches to support members of the tree canopy and shrub strata breeding and foraging guilds.

Guild Management Guidelines

Shrub breeders and foragers

- Patches of shrub habitat greater than the average reported territory size of shrub nesting passerines (0.83 acres) should be maintained.
- The greater the number of patches, the larger the patch size, and the closer patches are to each other the greater occupancy rate and productivity of guild members.
- Greater volume of shrub foliage in habitat patches provides better security cover by impeding the movement of predators and shielding the nest and/or activities of parents and neonates that can alert a predator.

Tree canopy breeders and foragers

- In general, higher breeding densities of individual guild members are associated with greater height to the bottom of the tree canopy and greater volume of individual tree canopies.
- For guild members that require deciduous tree cover, greater habitat occupancy is found in larger habitat patches in close proximity to other suitable patches in the landscape.

Strategies

- Meeting aspen/shrub riparian objectives will require strategies that can return dominance of aspen and deciduous shrubs to stands where ponderosa pine is climax, regenerate declining, even-aged stands, and restore degraded stream side riparian habitat. The periodic use of prescribed fire can remove advance regeneration of ponderosa pine and kill above ground aspen stems stimulating regeneration through root sprouting.

- Where mature pines are suppressing aspen growth and vigor, commercial harvest or non-commercial thinning can be used to remove trees(see Strategies for Objective 3a). Pine trees greater than 24 inches in diameter at breast height can be killed and left as snag habitat. If these large diameter pines, represent the only old growth pine remaining in an area they should be maintained.

- Restoration of degraded riparian habitats can be accomplished through the use of plantings. An excellent discussion of species and techniques related to plantings are provided by Monsen (1983) and in a symposium proceedings compiled by Clary et al. (1992). This strategy has already been employed on the reach of Pine Creek from Headquarter Pond to Winslow Pool using volunteers from the local Audubon chapter and scout groups. Rooted stock of thin-leafed alder (*Alnus incana*), black cottonwood (*Populus trichocarpa*), aspen, and red-osier dogwood have been used in these plantings. Because many of these areas are currently dominated by reed canarygrass, a planting area of approximately 16 ft^2 was cleared to reduce competition with shrub and tree plantings.

Rationale

Aspen dominated forest stands are a critical resource for species requiring both cavities and deciduous foliage in tree and shrub canopies for breeding and foraging. These aspen and deciduous shrub riparian habitat types have been significantly reduced on the refuge by competition from encroaching ponderosa pine and the suppression of aspen and shrub regeneration by past grazing. Aerial coverage of aspen and deciduous shrub dominated plant communities has been reduced by 65%. Existing stands are dominated by overmature trees with little regeneration. In the past, periodic fire removed encroaching pines and encouraged regeneration of aspen and understory shrubs.

3D. DOWNED LOGS OBJECTIVE: Annual forest management activities will provide at least 4 downed trees per acre, 15 to 17 inches in diameter at the large end and 20 feet or more in length to support the members of the terrestrial covered surface breeding guild requiring this habitat feature.

Guild Management Guidelines

Terrestrial covered surface breeders

- Several guild members require large dead and down material as cover above the soil surface. At least 4 logs, 15 to 17 inches in diameter at the large end and 20 feet or more in length should be maintained per acre.

Strategies

- Long-term strategy for meeting objectives for snags and downed woody material requires the restoration and maintenance of forest stand conditions that foster recruitment and retention of large diameter snags.(see Strategies Objective 3a).

Rationale

Coarse woody debris is an important breeding stratum for several members of the terrestrial covered surface breeding and foraging guilds. Current levels of large woody debris is considerably higher than presettlement conditions as a result of the suppression of fire and higher fall rates associated. Reintroduction of fire during forest restoration strategies will likely reduce the quantity and distribution of this habitat feature.

GOAL # 4. Protect and restore the natural distribution and diversity of grassland and shrub steppe habitats to benefit indigenous wildlife.

4A. LITTER COVER PERCENT OBJECTIVE: Annually, maintain at least 75% of grassland and steppe habitats as nesting cover for resident and migratory birds as indicated by at least 50% ground cover of litter and a visual obstruction measurement greater than 8 inches taken prior to any spring growth.

Guild Management Guidelines

Terrestrial cover surfaced breeders

- For upland nesting waterfowl and other waterbirds, areas of grass and low shrub cover within 200 yards of brood-rearing wetlands is of critical importance.
- A residual vegetation component should be maintained in at least 75% of the wet meadow and grass and low shrub dominated upland plant communities. As a rule, the maintenance of a visual obstruction reading of 10 inches or greater taken prior to initiation of current years growth will provide the best nesting cover. Visual obstruction is measured by estimating the height a pole is completing hidden from view by an individual 13.4 feet away.
- Litter is an important component of the terrestrial covered surface stratum and should be present but not in excess of 50% ground cover or a depth of 1 inch.

Rationale

Nearly all members of the terrestrial covered surface breeding guild require grass cover and litter. This requirement is particularly true of upland nesting waterfowl with three exceptions. Both the mallard and gadwall have been found in a variety of cover types and frequently use low shrubs and dense forbs that provide adequate concealment(Greenwood et al , 1995). Nest of green winged teal are often found in areas of tree and shrub cover and security cover is often provided by low shrubs and downed logs. Blue-winged teal, cinnamon teal, northern pintail, and northern shoveler nest are found primarily in grass dominated cover (Greenwood et al 1995). Several species especially the sparrows, also require grass and litter as a ground cover component. Wray and Whitmore(1979) found that successful vesper sparrow nest had a greater percentage of litter cover than unsuccessful nests. In a study of shrub-steppe birds of the Great Basin, Wein and Rotenberry(1981) found that grasshopper sparrows, meadowlarks and savannah sparrows were associated with greater grass and litter cover. The song sparrow, California quail and ruffed grouse utilize grass and litter cover under an overstory of shrubs or trees.

4B. ENCROACHING PINE REMOVAL OBJECTIVE: Restore and maintain the open grassland aspect to at least 50 acres of steppe habitat annually through removal of encroaching ponderosa pine trees.

Rationale

Many of the terrestrial covered surface breeding guild members that breed in the steppe portion of the Channeled Scablands avoid areas of extensive tree cover. Increasing canopy cover can also reduce grass cover a critical component of breeding habitat for members of this guild.

4C. EXOTIC PLANT SPECIES CONTROL OBJECTIVE: Control exotic plant species on between 25 and 50 acres of upland grassland and steppe habitats annually and by 1999 initiate an experimental program to investigate strategies to reduce the dominance of cheatgrass and restore native plant communities.

Strategies

- The primary strategy for controlling the expansion of introduced plant species will be maintenance of vigorous native plant communities. Soil disturbance will be kept to a minimum during habitat and facility management activities. Where soil disturbance does occur, disturbed sites will be replanted with native species.
- The control strategies for 6 herbaceous noxious plant species will include mowing of roadsides, manual pulling, discing and reseeding with native species, release of biological control agents, and use of herbicides (HMP Table 8).
- An experimental program will be initiated to determine the feasibility of using late winter and early spring burning followed by seeding of native plant species to control cheatgrass in steppe and forested habitats.

Rationale

The main limitation to achieving objectives for refuge steppe and grassland areas is the presence of exotic plant species. Exotic species were established in this community during past agricultural practices that involved farming and livestock grazing. These practices introduced the seeds of exotic species and disturbed the soil surface allowing invasion of native plant associations. The primary exotic species in these stands include cheatgrass brome (*Bromus tectorum*), ventanata (*Ventanata dubius*), St. Johns Wort , dalmatian toadflax, diffuse and spotted knapweed, and leafy spurge. Many of the mound areas in refuge steppe habitats are dominated by cheatgrass and ventanata with few remaining native species. Cheatgrass decreases the survival of native perennial seedlings by rapidly exploiting available soil water and nutrients (Harris 1967). Cheatgrass germinates earlier and over a longer period of time and continues root growth during cooler temperatures than native perennial species. The productivity and density of cheatgrass on the mounds and its early senescence also create a thick layer of thatch that further decreases survival of native plant seedlings, reduces the vigor of native forb species, reduces the cover of cryptogamic soil crust and may increase the frequency and intensity of fires(Mack 1981 and Tausch et al. 1994). Increased fire frequency and intensity further modifies steppe plant communities favoring cheatgrass.

4D. IDENTIFICATION OF INTACT GRASSLAND AND STEPPE OBJECTIVE: By 2000, identify areas of intact native upland grasslands and meadow steppe habitat adjacent to the refuge and through cooperation and coordination with private landowners, local, state and federal agencies, and private organizations maintain these lands as native plant communities.

GOAL #5. Maintain the biodiversity of the refuge through support of the conservation of threatened and endangered species in their natural ecosystems

5A. WATER HOWELLIA RESEARCH AND MONITORING OBJECTIVE: By 1999, conduct research and monitoring to answer critical questions about habitat requirements and species biology in order to design sound management plans for restoring and maintaining natural occurrences of water howellia.

Strategies

- Work with the Endangered Species Office and university researchers to develop a research design and acquire funding for this project.

Rationale

The Refuge contains 35 of 170 known occurrences of this species. Water howellia was listed as a threatened species under the Federal Endangered Species Act by the U.S. Fish and Wildlife Service in July 1994. A recovery plan is being drafted for the species. The recovery objective in the draft plan is " ... to provide an adequate level of protection for the species and its habitats so that there will be self-sustaining populations distributed throughout its range." Development and implementation of habitat management plans to sustain water howellia on federal lands is a Priority 1 recovery action..

Little information is available on the historic occurrence of this species on the refuge. Alteration of refuge wetlands through the years may have had a negative impact on this species reducing the amount of suitable habitat. Management or historic land use activities that significantly altered the basin bottom through mechanical excavation, combustion or sedimentation may have displaced the seedbed or caused direct mortality of seeds and jeopardized sub-populations of this species. Alteration of the hydrologic regime of a wetland through drainage or changes in the water yield of watersheds due to increased coniferous forest cover may have reduced the amount of available habitat. The introduction of evasive exotic species capable of invading water howellia habitat, such as reed canarygrass, may have through competition for light and space reduced or eliminated the area of suitable habitat in refuge wetland basins. Changes in water chemistry or temperature as a result of increased sedimentation or nutrient input could have resulted in changes in macrophyte and algal communities that may adversely affected the survival of individual populations through competition for light and space.

Research is needed on the ecology of water howellia, impacts of management actions on howellia and its habitat, and control methods for reed canarygrass. The findings of this research would assist in the development of more specific management plans.

5B. HOWELLIA PRECAUTION OBJECTIVE: Assure that annual management activities adjacent to known occurrences of water howellia do not create habitat conditions that fall outside the range of suitability for this species and may jeopardize its continued existence.

Strategies

- A survey for water howellia will be completed in all historic and potential habitats prior to any management treatment that may alter its habitat. Known occurrences will be avoided or restoration foregone in occupied wetlands.
- Forest restoration activities involving commercial tree harvest and restoration of seasonal wetlands have a potential to increase soil erosion and sedimentation. Mitigative measures would be utilized to minimize the risk to water quality that can impact important wetland values including the threatened plant species, water howellia. All tree harvest activities would take place only during periods of time that soils are resistant to compaction and erosion(dry or frozen). Log skidding will be minimized and landing areas will be dispersed and placed to avoid long skid trails. The butt-end of all felled trees would be lifted off the ground when skidded. Wide wheeled or tracked vehicles would be required to minimize impacts associated with rutting and disturbance of soil cover. Where possible harvester loaders and Feller/bunchers would be utilized to reduce damage from skidding. All disturbed areas including skid trails, landings and temporary access roads would be rehabilitated by replacing topsoil and seeding with native species. Hydro-seeding or a slurry mulch would be utilized in areas where greater than 75% of the ground cover is removed.
- Any tree harvest adjacent to wetlands would require that trees be felled away from the wetland and no tracked vehicle would be allowed within 25 yards of a wetland edge. Use of heavy equipment in wetland habitats for restoration purposes would be conducted when possible when the area is dry to avoid sediment movement throughout the basin.. Work would also be restricted to periods when water is static between ponds preventing transport of sediment between wetlands.

Rationale

Management activities in wetlands and uplands that disturb the soil (island removal, tree harvest, log skidding, prescribed fire etc.) have the potential to negatively impact water howellia. Increased sedimentation in wetlands can directly impact howellia by burying the seed bed thereby preventing germination or covering seedlings. Sedimentation can indirectly impact this plant species by altering water chemistry and light penetration that may change the associated plant community and existing competitive relationships. Use of heavy equipment in wetlands can also directly impact howellia by either displacing the seed bed or causing direct mortality to seedlings.

***5C. REDUCTION OF REED CANARYGRASS COMPETITION OBJECTIVE*:** By 2000, identify and apply on an experimental basis management strategies that may reduce the impact of reed canarygrass on the survival of water howellia.

Strategies

- Work with the Endangered Species Office and university researchers to develop a research design and acquire funding for this project.

Rationale

The introduction of evasive exotic species capable of invading water howellia habitat, such as reed canarygrass, may have through competition for light and space reduced or eliminated the area of suitable habitat in refuge wetland basins.

5D. HOWELLIA EDUCATION OBJECTIVE: By 2001, form partnerships with local, state, and federal agencies, and private organizations and individuals to develop and initiate an educational program concerning conservation of water howellia on private land.

Strategies

- An integral part of the proposed actions to protect water howellia habitat is an outreach and education program that informs the general public of its ecology and current and potential threats to its viability and strategies to minimize these threats. The refuge currently has an outreach and environmental education program directed at school-age children. This program needs to be extended to the community-at-large including refuge neighbors, local government agencies, and private groups and individuals. This can be accomplished by development of outreach media including pamphlets, posters, video programs, community service projects and presentations by refuge staff to local business and service groups. Without an informed public, it will be difficult to accomplish objectives that involve the development of partnerships to minimize the impacts of private land use activities on howellia habitat and the refuge.

Rationale

A large percentage of the meta-population that includes the Turnbull NWR sub-populations occurs on non-federal lands. Because there is no regulatory authority to protect threatened species on these lands, outreach is needed in order to promote voluntary involvement in howellia habitat protection.

5E. HOWELLIA HABITAT PROTECTION OBJECTIVE: By 2001, explore options to protect additional water howellia habitat off refuge.

Rationale

Numerous potential howellia wetlands occur within the landscape surrounding the refuge. Recovery of this species requires that it ‘s current geographic distribution is maintained. This requires not only protection of occurrences on federal lands, but further protection of sub-populations within a larger meta-population.

GOAL #6. Support the maintenance of biologically effective landscape linkages and corridors between the refuge and other intact areas of vegetation zones representative of this ecoregion.

6A. PARTICIPATION IN COUNTY / MUNICIPALITY PLANNING OBJECTIVE: On a continuing basis, provide input into growth management planning of the counties and local municipalities surrounding the refuge to assure the maintenance of lands with natural vegetative cover between the refuge and other large intact natural areas.

Strategies

- Refuge staff will provide input on state, county, and local permits and proposed zoning changes that will affect land use of important areas adjacent to the refuge.
- Work with regulatory agencies to provide input to and improve compliance of land and water protection ordinances.

Rationale

For most of the refuge's existence, surrounding land use has mostly complemented the refuge by maintaining open space, providing a larger habitat base, and serving as critical linkage to other undisturbed habitats. However, in the past twenty years, Spokane County's population has increased by 30%. Accelerated home construction, business developments, and the transportation infrastructure to service this growing population have begun to isolate the refuge from other undisturbed habitat. This development increases the potential for threats such as contamination of air and water, altered or depleted supplies of surface and ground water, loss of connectivity to other suitable or complimentary habitats, and the invasion of exotic plant and animal species that erode the integrity o f the refuge. The above strategies will help to minimize the negative impacts of the area's growth.

6B. MAINTENANCE OF NATIVE LAND COVER OBJECTIVE: Through coordination and cooperation with private landowners, local, state, and federal agencies, and private organizations identify opportunities to maintain the native land cover on properties within undeveloped areas contiguous with the refuge that support the goal of maintaining landscape linkages and corridors.

Strategies

- Work with partners to expand the currently limited refuge education and outreach program to include refuge neighbors, local, state, and federal government agencies, private organizations and individuals.
- Coordinate with the above mentioned groups to identify opportunities to maintain native land cover .
- Use cooperative agreements, acquisition of easements and fee-title purchase to protect native land cover within the approved refuge boundary and encourage landowner participation in conservation programs within the stewardship area.

Rationale

For most of the refuge's existence, surrounding land use has mostly complemented the refuge by maintaining open space, providing a larger habitat base, and serving as critical linkage to other undisturbed habitats. However, in the past twenty years, Spokane County's population has increased by 30%. Accelerated home construction, business developments, and the transportation infrastructure to service this growing population have begun to isolate the refuge from other undisturbed habitat. This development increases the potential for threats such as contamination of air and water, altered or depleted supplies of surface and ground water, loss of connectivity to other suitable or complimentary habitats, and the invasion of exotic plant and animal species that erode the integrity o f the refuge. The above strategies will help to minimize the negative impacts of the area's growth.

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